COST OPTIMIZATION OF BATHROOM SCALE BY USING BOOTHROYD-DEWHURST DFA METHOD

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Thesis submitted in fulfillment of the requirements

for the award of the degree of

Bachelor of Mechanical Engineering with Manufacturing Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2010

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion this project is adequate in terms of scope and quality for the award of the Degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this report entitled "Cost optimization of bathroom scale by using Boothroyd-Dewhurst DFMA method" is my own except for the quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of any other degree.

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DEDICATION

Encik Annuar B. Ariffin

Puan Omu Kalsom Bt. Yakub

and

beloved sisters and brothers

ACKNOWLEDGEMENT

This project was conducted under the supervision of Mr. Hadi B. Abdul Salaam in Universiti Malaysia Pahang. I am very grateful for his patience and his constructive comments that enriched this research project. His time and efforts have been a great contribution during the preparation of this thesis that cannot be forgotten forever. I would like to thank to all the lecturers and technicians at the Faculty of Mechanical (FKM) UMP for their valuable comments and sharing their time and knowledge on this research project during my last trip to submit the project. I also gratefully acknowledge the assistance of everybody who helped in the execution of this project in Universiti Malaysia Pahang.

I would like to thank Mr. Hadi B. Abdul Salaam for general help with the facilities, who have given his full effort in guiding to achieve the goal as well as his encouragement to maintain our progress in track. I would to appreciate the guidance given by other supervisor especially in our project presentation that has improved our presentation skills by their comment and tips. I also want to thanks to my friends for their friendship and help when thinking through problems and for sharing their knowledge of experimental apparatus and computer systems. Finally, I thank to my family for their continuous support and confidence in my efforts.

I also gratefully acknowledge the assistance of everybody who helped in the execution of this project in the University Malaysia Pahang, especially to the Mechanical staff and student. Not forgotten to Dean of Mechanical faculty for general help with the facilities. Many thanks go to the all lecturer and supervisors who have given their full effort in guiding the team in achieving the goal as well as their encouragement to maintain our progress in track. My profound thanks go to my BMF students and my family for their continuous support and confidence in my effort.

ABSTRACT

The ability to quickly develop new products, which are of the lowest cost, the highest quality and the fewest environment impact, as a key factor to meet a global market demand. Design for Manufacture and Assembly (DFMA) has been most widely applied in industries with most impressive achievements. There are three well-known DFMA tools; Boothryod-Dewhurst, Hitachi and Lucas-Hull. But for this project, the method used was Boothryod-Dewhurst only. This project is about analyzing the cost optimization of bathroom scale by using DFMA method. The method will help to identify the unnecessary component inside the bathroom scale and help to minimize the assembly time hence reduce the cost of the product. After evaluate the current design, the design efficiency is 28.86% and the assembly cost is RM 0.30418. By using Boothroyd-Dewhurst method, create five new designs for bathroom scale and make analysis for each design using Boothroyd-Dewhurst manual handling and insertion table. From the result, design five has the highest design efficiency which is 36.11% and the assembly cost is the lowest from other design which is RM 0.22659. When implementing the new design in the bathroom scale production line, the productivity of the product increases from 16 products per hour to 20 products per hour. The total assembly times reduce from 3.6387 minutes to 2.9082 minutes. And the labour rate decreases from RM 0.3125 to RM 0.25. Current design has total parts of 25 meanwhile new design only have 23 parts.

ABSTRAK

Keupayaan untuk menghasilkan produk baru yang mempunyai ciri-ciri seperti mempunyai kos yang rendah, kualiti yang tinggi dan menghasilkan impak yang minimum pada persekitaran merupakan faktor utama dalam memenuhi pasaran antarabangsa. Rekabentuk untuk Pembuatan dan Pemasangan (DFMA) telah digunakan di dalam industri secara meluas dan telah menghasilkan banyak kejayaan. Terdapat tiga kaedah yang biasa digunakan iaitu Boothryod-Dewhurst, Hitachi dan Lucas-Hull. Tetapi untuk projek ini, hanya kaedah Boothryod-Dewhurst sahaja yang digunakan. Projek ini berkenaan dengan mengoptimumkan kos bagi penimbang berat dengan menggunakan kaedah Rekabentuk untuk Pembuatan dan Pemasangan (DFMA). Kaedah ini akan membantu mengenalpasti komponen- komponen yang tidak diperlukan di dalam penimbang itu dan membantu untuk meminimumkan masa pemasangan seterusnya mengurangkan kos pengeluaran penimbang berat. Pertama sekali kesemua komponen di dalam penimbang berat diceraikan dan dianalisis. Kecekapan rekabentuk yang diperolehi ialah 28.86% dan kos pemasangan ialah RM 0.30418. Dengan menggunakan kaedah Boothroyd-Dewhurst, lima rekabentuk baru telah dicipta dan kemudian kesemua rekabentuk dianalisa dengan menggunakan jadual 'Boothroyd-Dewhurst manual handling and insertion'. Hasil dari analisis didapati bahawa rekabentuk lima mempunyai kecekapan rekabentuk yang paling tinggi iaitu 36.11% dan mempunyai kos pemasangan yang paling rendah iaitu RM 0.22659. Apabila rekabentuk baru diguna dalam penghasilan penimbang berat, produktiviti produk meningkat dari 16 produk terhasil dalam masa sejam kepada 20 produk. Jumlah masa pemasangan juga menurun dari 3.6387 minit kepada 2.9082 minit. Kadar upah juga menurun dari RM 0.3125 kepada RM 0.25 bagi satu produk. Rekabentuk asal terdiri dari 25 buah komponen dan apabila menggunakan rekabentuk baru, komponen di dalam penimbang berat mempunyai 23 buah komponen sahaja.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Every decision that we make can cost us. Whether the goal is cost leadership in the industry or differentiating product from the competition, we can achieve a sustainable advantage when product sourcing, manufacturing, and design decisions are based on early cost knowledge that we can count on.

In manufacturing industry, the product improvement without increasing the cost is very important. Due to this, we should choose most appropriate method to reduce the cost. Product developers often find themselves relying on historical manufacturing and assembly costs recorded for previous or similar versions of a product. For examples, the supplier best estimates.

Nowadays, there is method that we can used to reduce the cost of the product which is called DFMA. DFMA is stand for Design for Manufacture and Assembly. It is a method that gives us tool we can use anytime during the product development lifecycle to analyze and understand the costs to manufacture and assemble the product. (Boothroyd et al., 1994)

DFMA may be divided into two methods which is DFM and DFM. DFM is Design for Manufacture. It is used to analyze and compare the costs of different material and manufacturing methods, in design phase. Meanwhile DFA is Design for Assembly. It is used to estimate the difficulty of assembly, eliminate unnecessary parts and assembly tooling, and design products that are less costly to manufacture.

1.2 PROJECT BACKGROUND

Today, there are many manufacture produce the similar product such as cars, mechanical equipments and computers. This scenario creates the competition among them because they have to ensure that their product is the first chosen product in the market. Because of this situation, the manufacture needs to use the DFMA method.

As mention earlier, DFMA method helps reducing the costs of producing the product by reducing the raw material and to eliminate the unnecessary parts in the product. The DFMA method can equip the quick and accurate cost information starting from the purchasing parts from the supply chain to the earliest conceptual stages of design.

The DFMA method was introduced to the marketplace by Dr. Boothroyd and Dr. Dewhurst in 1983. Some of the company that used this method are Harley-Davidson, John Deere and Abbott laboratories.

1.3 PROBLEM STATEMENT

Nowadays, a weight scale are widely use by the customer especially for the women because they are really emphasize about their weight. So the product life volume for this product must be high due to high demand by the user. Thus, any reduction in the bathroom scale production can be very significant to the manufacturer in term of profit and production cost.

The main purpose of this study is to disassemble the bathroom scale and reduce the unnecessary part for optimizing the use and for lower the production cost using the Boothryod-Dewhurst Design for Manufacture and Assembly (DFMA) method.

Continuous development of bathroom scale can lead to improvement of manufacturing and assembly process, thus enhance rapid development of technology in manufacturing technology.

1.4 OBJECTIVE OF STUDIES

The main objectives of this study by using the DFMA method are to:

(i) Analyze a current product design for assembly efficiency.
(ii) Redesign the product for improved assembly operations.
(iii) Select the best option that can be implementing for redesign.

1.5 SCOPE OF STUDIES

In order to achieve the objectives, the following scopes of studies are performed:

(i) Gathering the information about the bathroom scale with the function of each of the component.
(ii) Design the current bathroom scale using the Solidwork software.
(iii)Dimensioning the current design by using the manual measured.
(iv)Redesign the product to get the minimum cost of production.

1.6 REPORT ARRANGEMENT

This report is devided into five chapters. Chapter one is the introduction about the project. It also includes the brief content, problem statement, objectives and scope of studies.

In chapter two is discussed about the literature review. This chapter provided with introduction of the product design strategies and method. In here, the general design has been discussed. Then it also includes the brief introduction to various methods of DFMA, model-driven design and life cycle.

The matter that includes for chapter three is methodology. Firstly, the designs of study and frame work are studied. Then it moves to the introduction to manual calculation of Boothroyd Dewhurst DFMA method.

For the chapter four, the design evaluation and CAD modelling are applied to the existing product assembly. All the disassemble parts of the weight scale are critiqued and measured. Then followed by the manual calculation to lead the time of assembly, estimated cost and design efficiency. In this chapter also performed the

suggestion for the new design of the weight scale. This chapter also discussed about results. In this chapter also mentioned about the best alternative design that we get during the analysis.

In chapter five, the conclusion and recommendation are made based on the result that have gain in the research.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discuss more specific about the Bathroom scale and DFMA method. For bathroom scale, this chapter review about it history, material used to make weight scale, the manufacturing process and the design. For DFA method, this chapter explain about basic design concept and guidelines of DFA method. This chapter also relates how product design affects the cost, cycle time, and overall product quality. About DFM, the discussion is about to improve the product during the design stage.

2.2 INTRODUCTION OF BATHROOM SCALE

Everybody use a weight scale to measure their body mass more than one time in the life time. Currently the weight scale or bathroom scale can be bought from almost anywhere. It is possible to say that every house at least have one weight scale in their house. This type of scale was called bathroom scale because it usually placed at the bathroom. There are many types of bathroom scale and it was discussed in the next sub-topic.

2.2.1 History of bathroom scale

The first measurement device was used by the Romans about 2,000 years ago. They devised an equal beam scale which was shaped like the letter T with both arms measuring 7.4 in (18.8 cm) wide. Attached to each arm were metal pans that were typically 1.5 in (4 cm) in diameter.The first known unit of weight was the wheat seed. The Romans and Greeks used it to measure the any other object, generally for barter system or trade. Then the Arabs improved on these techniques and established weight standards for gold, silver and gems. (Blanchfield, 2001)

During thirteen century, the trade become much more widespread but people across the world use different standards of measurement. Then, King Edward I establish a base standard of measurement to which objects or material could be compared to. Then, the French government devised a system based on a line running along the ground through Paris that measured the distance from the North Pole to the Equator in 1793. This measurement was called metric system and became accepted by Europeans in 1837.

Scale then continued to evolve to meet both the distributor and customer's need. The customer wanted to be able to count on the accuracy of the distributor's scale to make sure that they were not be cheated. The first scale was used a simple balance beam to weight of an object against a known standard.

For today's weight scale, it was invented by Richard Salter in Bilson, England. These bathroom scales use a spring balance to measure the weight. The Salter's brand was also the first company in England to marked bathroom scale. Modern home scale have evolved from these early industrial prototypes. Nowadays, the scale is based on the same spring balance idea.

2.2.2 Bathroom scale design

There are many kinds of bathroom were designed nowadays. For examples, solar, electronic, digital and spring. Their function may also differ on what of the measure. Some types of scale for example can measure a person's body fat ratio. The colour and style are made variously to meet the satisfaction of the customers need.

A typical spring scale is comprised of weight transmitting levers, a weight sensing mechanism, and dial enclosed in a metal casting. Generally, the scale is equipped with a non-slip pad on the platform so that the person does not slip and fall off the scale.

The spring scale is manufactured from stainless steel or aluminium. The interior is composed of metal springs, pins, gears and plastic. The gears can be made from aluminium, copper, brass, bronze, stainless steel, nickel silver, monel, zinc, iron, or plastic. The non-slip mat is formed from a mix of poly vinyl chloride and rubber.

2.2.3 Manufacturing process for bathroom scale

These are the steps of manufacturing the bathroom scale. It started with aluminium is melted until molten and then fed into a die that has the desired shape of the scale casing. The aluminium is cast in a cold chamber process at temperature of 650^{o}C. It is important to maintain the temperature at that state so that it will not be bond with the steel die. Next, the aluminium was cooled and ejected from the mould. Both of top and bottom of the scale body was manufactured by this process. (Blanchfield, 2001)

Figure 2.1: Scale Casing

(Source: How stuff works, 2000)

The top of the case is manufactured with a slot missing that will act like window through which to view the person's weight. And the slot is covered with plastic. The plastic was made from molted plastic fed into an injection molding machine. Then it is injected again into the mold of the cover and left until its cool. After cooling, the cover is removed and manually inserted into the top casing.

There are four levers were used to distribute a person's weight through the scale. The levers are manufactured from thin sheet of aluminium or steel that is delivered to the plant. The sheets are then placed on a conveyor belt to be laser cut. A laser beam that is 0.2 mm in diameter focuses 1000-2000 watts on the aluminium sheets. The laser gets the outline of the lever and instructions from a Computer Aided Drafting and Design (CAD) drawing.

Figure 2.2: Levers

(Source: How stuff works, 2000)

The dial is formed from a coining method. In this process, the aluminium is placed in a set of dies that close, exerting up to 20000 psi, depending on the level of detail on the dial. Then the dial is extracted and automatically painted, typically white with black numbers. For springs, brackets, and gears arrive preformed at the plant. They are inspected for quality and then distributed to workstations along an assembly line.

Figure 2.3: Dial

(Source: How stuff works, 2000)